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(54) Duplexer and communication apparatus

(57) The invention provides a duplexer (15) comprising:

a frequency variable filter (13) switching between a first band and a second band by a voltage-controllable reactor D1; and a transmission/reception select switch (14) connected to an input/output terminal of an end of the frequency variable filter (13).

The above duplexer is small and capable of efficiently eliminating harmonics of transmission signals generated by a transmission/reception select switch.

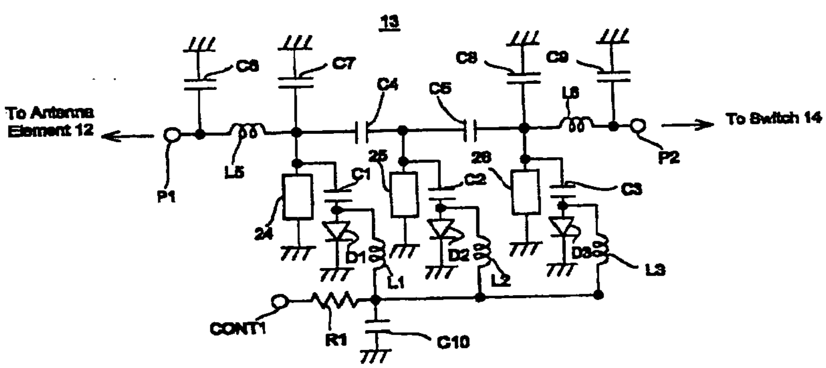

Fig. 2

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a duplexer and a communication apparatus, for example, used in a microwave band.

[0002] As one of cellular phone systems, there is provided a time-division multiple access system. Fig. 10 is an electric-circuit block diagram of the RF transmission/reception section of a cellular phone 1 using this system. In Fig. 10, reference numeral 2 denotes an antenna element, reference numeral 4 denotes a transmission/reception select switch, reference numeral 5 denotes a transmission filter, reference numeral 6 denotes a reception filter, reference numeral 7 denotes a transmission circuit, and reference numeral 8 denotes a reception circuit. In many cases, the transmission/reception select switch 4 is composed of a PIN diode, or a GaAs switch IC, etc., is used as the switch.

[0003] The cellular phone 1 shown in Fig. 10, however, needs the transmission filter 5 and the reception filter 6. As a result, this is a hindrance to reduction in size and cost of the cellular phone 1. In addition, since the transmission/reception select switch 4 composed of the PIN diode or the like has non-linearity, high-output transmission signals are distorted by the switch 4, an unnecessary harmonic such as the second harmonic or the third harmonic in the transmission signals occurs. Thus, as the solutions to the problem, a low pass filter or the like is externally added to the antenna element 2, power consumption of the PIN diode is increased in the case of the transmission/reception select switch 4 composed of the PIN diode. However, the former method leads to increase in size of the cellular phone 1, and the latter one leads to battery exhaustion.

SUMMARY OF THE INVENTION

[0004] To overcome the above described problems, the present invention provides a small duplexer and a small communication apparatus capable of efficiently eliminating the harmonic of transmission signals generated by a transmission/reception select switch.

[0005] The present invention provides a duplexer including: a frequency variable filter for switching a first band and a second band by a voltage-controllable reactor; and a transmission/reception select switch connected to an input/output terminal of an end of the frequency variable filter.

[0006] The frequency variable filter may include a low pass filter. As the reactor, a PIN diode, field effect transistor, or the like may be used. As the transmission/reception select switch, an element composed of a PIN diode, a GaAs switch IC, or the like may be used. As a resonator of the frequency variable filter, a dielectric resonator or the like may be used.

[0007] The above arrangement permits the single frequency variable filter to be used both as a transmission filter and a reception filter, so that reduction in size of the duplexer can be achieved. In addition, since the frequency variable filter includes a low pass filter, the frequency variable filter eliminates unnecessary harmonics generated by the distortion of transmission signals.

[0008] In the above described duplexer, the first and second bands of the frequency variable filter may be respectively divided into a plurality of frequency regions, and one of which may be selected by exercising voltage-control on the reactor. This permits the distance (isolation) between the transmission band and the reception band of the antenna duplexer to be expanded, so that filter characteristics can be even further improved.

[0009] The present invention further provides a communication apparatus including one of the above described duplexers. As a result, miniaturization of the communication apparatus and elimination of unnecessary harmonics generated by the distortion of transmission signals can be achieved.

[0010] Other features and advantages of the present invention will become apparent from the following description of the invention which refers to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0011]

Fig. 1 is a block diagram of an electric circuit showing an embodiment of a communication apparatus in accordance with the present invention.
Fig. 2 is an electric circuit diagram of a frequency variable filter used in an antenna duplexer shown in Fig. 1.
Fig. 3 is a sectional view showing an example of a resonator used in the frequency variable filter shown in Fig. 2.
Fig. 4 is a perspective view showing a structure in which the frequency variable filter shown in Fig. 2 is mounted.
Fig. 5 is an electric circuit diagram showing a transmission/reception select switch used in the antenna duplexer shown in Fig. 1.
Fig. 6 is a graph showing the filter characteristics of the antenna duplexer shown in Fig. 1.
Fig. 7 is an electric circuit diagram showing a frequency variable filter used in another antenna duplexer in accordance with the present invention.
Fig. 8 is an electric circuit diagram showing a frequency variable filter used in another antenna duplexer in accordance with the present invention.
Fig. 9 is a graph showing the filter characteristics of the antenna duplexer shown in Fig. 8.
Fig. 10 is an electric-circuit block diagram showing a conventional communication apparatus.

DESCRIPTION OF THE EMBODIMENTS

First Embodiment, Figs. 1 to 6]

[0012] Fig. 1 is an electric-circuit block diagram of the RF transmission/reception section of a cellular phone 11 as a communication apparatus. In Fig. 1, reference numeral 12 denotes an antenna element, reference numeral 15 denotes an antenna duplexer, reference numeral 17 denotes a transmission circuit, and reference numeral 18 denotes a reception circuit. The antenna duplexer 15 is comprised of a frequency variable filter 13 and a transmission/reception select switch 14.

[0013] As shown in Fig. 2, the frequency variable filter 13 has an arrangement such that resonators 24, 25, and 26 are triple-coupled via coupling capacitors C4 and C5. An input/output terminal P1 of the frequency variable filter 13 is electrically connected to the resonator 24 via a π-type LC circuit (a low pass filter) comprised of a coupling coil L5, and capacitors C6 and C7. Similarly, an input/output terminal P2 is electrically connected to the resonator 26 via a π-type LC circuit (a low pass filter) comprised of a coupling coil L6, and capacitors C8 and C9. As shown here, the frequency variable filter 13 includes a low pass filter.

[0014] A PIN diode D1 as a reactor is electrically connected in parallel to an end of the resonator 24 via a band varying capacitor C10 under a condition in which the cathode of the diode is grounded. Similarly, a PIN diode D2 is electrically connected in parallel to an end of the resonator 25 via a band varying capacitor C2 in such a manner that the cathode of the diode is grounded. A PIN diode D3 is electrically connected in parallel to an end of the resonator 26 via a band varying capacitor C3 under a condition in which the cathode of the diode is grounded.

[0015] A voltage-control terminal CONT1 is electrically connected to the intermediate node between the anode of the PIN diode D1 and the band varying capacitor C1 via a control-voltage supplying resistor R1, a capacitor C10, and a choke coil L1. Similarly, the voltage-control terminal CONT1 is electrically connected to the intermediate node between the anode of the PIN diode D2 and the band varying capacitor C2 via the control-voltage supplying resistor R1, the capacitor C10, and a choke coil L2, and is also electrically connected to the intermediate node between the anode of the PIN diode D3 and the band varying capacitor C3 via the control-voltage supplying resistor R1, the capacitor C10, and a choke coil L3.

[0016] In addition, for example, as shown in Figs. 3 and 4, $\lambda/4$ dielectric resonators are used as the resonators 24 to 26. Fig. 3 shows the resonator 24 as a representative example thereof. The dielectric resonators 24 to 26 are composed of a dielectric block 31 of a rectangular parallelepiped shape formed of a material with a high dielectric constant such as a ceramic material of TiO_2, resonator holes 32a, 32b, and 32c formed in the dielectric block 31, an outer conductor 37 disposed on the periphery of the dielectric block 31, and an inner conductor 38 disposed on the respective inner peripheries of the resonator holes 32a, 32b, and 32c. The outer conductor 37 is electrically open (disconnected) from the inner conductor 38 at one opening end face 31a (hereinafter referred to as an open-side end face 31a) of the dielectric block 31, whereas it is electrically short-circuited (connected) to the inner conductor 38 at the other opening end face 31b (hereinafter referred to as a short-circuited-side end face 31b). In the dielectric resonator 24, a series circuit of the band varying capacitor C1 and the PIN diode D1 is electrically connected to the open-side end face 31a in such a manner that an end of the band varying capacitor C1 is connected to the inner conductor 38 and the cathode of the PIN diode D1 is connected to a ground, whereas the outer conductor 37 is grounded to a ground at the short-circuited side end face 31b. Fig. 4 is a perspective view of the frequency variable filter 13 in which individual components are mounted on a substrate 40. The circuitry pattern made on the substrate 40 is not shown in the figure.

[0017] The transmission/reception select switch 14, as shown in Fig. 5, is comprised of PIN diodes D4 and D5. The cathode of the PIN diode D4 is electrically connected to an antenna terminal 14a via a coupling capacitor C11, and also electrically connected to a reception terminal 14c via a phase shifter 42 and a coupling capacitor C13. The anode of the PIN diode D4 is electrically connected to a transmission terminal 14b via a coupling capacitor C12.

[0018] The voltage-control terminal CONT1, the control-voltage supplying resistor R1, and the capacitor C10 are used together with the frequency variable filter 13. The voltage-control terminal CONT1 is electrically connected to the intermediate node between the anode of the PIN diode D4 and the capacitor C12 via a control-voltage supplying resistor R1, a capacitor C10, and a phase shifter 41. In addition, the anode of the PIN diode D5, the cathode thereof being grounded, is electrically connected to the intermediate node between the phase shifter 42 and the capacitor C13. In this arrangement, the phase shifters 41 and 42 are, for example, comprised of strip lines.

[0019] Next, a description will be given of the operational advantages of the antenna duplexer 15 having the above structure. In the antenna duplexer 15, transmission signals input from the transmission circuit 17 are output to the antenna element 12, and reception signals input from the antenna element 12 are output to the reception circuit 18.

[0020] The passing frequency of the frequency variable filter 13 is determined by the respective resonant frequencies of a resonance system comprised of the band varying capacitor C1 and the resonator 24, a resonance system comprised of the band varying capacitor C2 and the resonator 25, and a resonance system com-

prised of the band varying capacitor C3 and the resonator 26. When the transmission circuit 17 is operated, a positive voltage as a control voltage is applied to the voltage-control terminal CONT1 to turn on the PIN diodes D1 to D3. This allows the band varying capacitors C1 to C3 to be respectively grounded via the PIN diodes D1 to D3 and the pass-band frequency of the filter 13 is thereby lowered. The low-frequency pass band is allocated to transmission signals (see Fig. 6).

[0021] Meanwhile, in the transmission/reception select switch 14, when a positive voltage is applied to the voltage-control terminal CONT1, the PIN diodes D4 and D5 are turned on. Consequently, the transmission terminal 14b is allowed to be connected to the antenna terminal 14a via the capacitor C12, the PIN diode D4, and the capacitor CL1. The intermediate note between the phase shifter 42 and the capacitor C13 is allowed to be grounded via the PIN diode D5. In other words, the reception terminal 14c is electrically disconnected from the antenna terminal 14a and the transmission terminal 14b by the capacitor C13 so as to turn the switch 14 onto the transmission side. As a result, transmission signals output from the transmission circuit 17 are transmitted to the antenna element 12 via the switch 14 and the frequency variable filter 13. Entering of the transmission signals into the reception circuit 18 from the transmission circuit 17 is prevented by the isolation of the switch 14.

[0022] In contrast, when the reception circuit 18 is operated, a negative voltage as a control voltage is applied to the voltage-control terminal CONT1 to turn off the PIN diodes D1 to D3. However, instead of applying a positive voltage, the control circuit for supplying a control voltage to the voltage-control terminal CONT1 may be given a high impedance of 100 KO or more to apply no voltage to the voltage-control terminal CONT1. As a result, the PIN diodes D1 to D3 can be turned off by making the control voltage OV. This permits the band varying capacitors C1 to C3 to be in an open state, and the pass-band frequency is thereby higher. The high-frequency pass band is allocated to reception signals (see Fig. 6).

[0023] Meanwhile, in the transmission/reception select switch 14, when a negative voltage is applied to the voltage-control terminal CONT1, the PIN diodes D4 and D5 are turned off. Thus, the antenna terminal 14a is allowed to be connected to the reception terminal 14c via the capacitor C11, the phase shifter 42, and the capacitor C13. In other words, the transmission terminal 14b is electrically disconnected from the antenna terminal 14a and the reception terminal 14c by the PIN diode D4, whereby the switch 14 is turned onto the reception side. As a result, reception signals input from the antenna element 12 are transmitted to the reception circuit 18 via The frequency variable filter 13 and the switch 14.

[0024] As described above, the filter 13 can have two different pass bands by grounding or opening the band varying capacitors C1 to C3 by exercising voltage control. That is, a single frequency variable filter 13 can be used both as a transmission filter and a reception filter, with the result that reduction in size of the antenna duplexer 15 can be achieved.

[0025] In addition, in the antenna duplexer 15, the frequency variable filter 13 includes the low pass filter comprised of the coupling coil L5, and the capacitors C6 and C7, and the low pass filter comprised of the coupling coil L6, and the capacitors C8 and C9. With this arrangement, unnecessary harmonics such as the second harmonic or the third harmonic of transmission signals generated by the transmission/reception select switch 14 can be efficiently attenuated by the low pass filters. Consequently, conventional problems such as increase in size of a device due to an externally added low pass filter and increase in power consumption can be solved.

[Second Embodiment, Fig. 7]

[0026] Fig. 7 shows a frequency variable filter 13A of the antenna duplexer used in a second embodiment. The frequency variable filter 13A is equivalent to the frequency variable filter 13, in which field-effect transistors 51, 52, and 53 are used as substitutes for the PIN diodes D1, D2, and D3. However, only on an input/output terminal P1 side is disposed a low pass filter (which is, specifically, a low pass filter comprised of a coupling coil L5, and capacitors C6 and C7). This low pass filter permits unnecessary harmonics of transmission signals generated by a transmission/reception select switch to be attenuated. An input/output terminal P2 is electrically connected to a resonator 26 via a coupling capacitor C21. An antenna duplexer including the frequency variable filter 13A having the above-described structure provides the same operational advantages as those in the antenna duplexer of the first embodiment.

[Third Embodiment, Figs. 8 and 9]

[0027] In the antenna duplexer of a third embodiment, a transmission band (or a reception band) is divided into a plurality of frequency regions: (it is divided into two frequency regions in the third embodiment), one of which can be selected. It is necessary for an antenna duplexer to maintain the isolation between a transmission band and a reception band by steeply attenuating the frequency regions in proximity to the transmission band and the reception band. Thus, measures have been usually taken which sacrifice insertion losses, increase the number of coupling stages of resonators, or the like. However, according to the antenna duplexer of the third embodiment, the distance (isolation) between the transmission band and the reception band can be expanded by selecting each one from the respective divided frequency regions of the transmission band and the reception band. As a result, it is not

necessary to steeply attenuate the frequency regions in proximity to the transmission band and the reception band, so that the filter characteristics of the antenna duplexer can be improved.

[0028] Fig. 8 shows a frequency variable filter 61 used in the antenna duplexer of the third embodiment. In the frequency variable filter 61, resonators 62 and 63 are double-coupled via a coupling capacitor C37. An input/output terminal P1 of the frequency variable filter 61 is electrically connected to the resonator 62 via a π-type LC circuit (a low pass filter) comprised of a coupling coil L16, and capacitors C38 and C39. Similarly, an input/output terminal P2 is electrically connected to the resonator 63 via a π-type LC circuit (a low pass filter) comprised of a coupling coil L17, and capacitors C40 and C41.

[0029] PIN diodes D10, D11, and D12 are electrically connected in parallel to an end of the resonator 62 via band varying capacitors C31, C32, and C33 under a condition in which the cathodes of the diodes are grounded. Similarly, PIN diodes D13, D14, and D15 are electrically connected in parallel to an end of the resonator 63 via band varying capacitors C34, C35, and C36 under a condition in which the cathodes of the diodes are grounded.

[0030] A voltage-control terminal CONT1 is electrically connected to the intermediate node between the anode of the PIN diode D10 and the band varying capacitor C31 via a control-voltage supplying resistor R2, a capacitor C42, and a choke coil L10, and electrically connected to the intermediate node between the anode of the PIN diode D13 and the band varying capacitor C34 via the control-voltage supplying resistor R2, the capacitor C42, and a choke coil L13. A voltage-control terminal CONT2 is electrically connected to the intermediate node between the anode of the PIN diode D11 and the band varying capacitor C32 via a control-voltage supplying resistor R3, a capacitor C43, and a choke coil L11, and electrically connected to the intermediate node between the anode of the PIN diode D14 and the band varying capacitor C35 via the control-voltage supplying resistor R3, the capacitor C43, and a choke coil L14. A voltage-control terminal CONT3 is electrically connected to the intermediate node between the anode of the PIN diode D12 and the band varying capacitor C33 via a control-voltage supplying resistor R4, a capacitor C44, and a choke coil L12, and is electrically connected to the intermediate node between the anode of the PIN diode D15 and the band varying capacitor C36 via the control-voltage supplying resistor R4, the capacitor C44, and a choke coil L15.

[0031] A description will be given of the operational advantages of the antenna duplexer, which includes the frequency variable filter 61 having the above structure and the transmission/reception select switch 14 shown in Fig. 5.

[0032] The passing frequency of the frequency variable filter 61 is determined by each resonant frequency of a resonance system comprised of the band varying capacitors C31, C32, and C33, and the resonator 62, and a resonance system comprised of the band varying capacitors C34, C35, and C36, and the resonator 63. When the transmission circuit 17 shown in Fig. 1 is operated, a positive voltage is applied to the voltage-control terminals CONT1, CONT2, and CONT3 to turn on the PIN diodes D10 to D15. This permits the band varying capacitors C31 to C36 to be respectively grounded via the PIN diodes D10 to D15, so that the frequency of the pass band of the filter 61 is the lowest. The lowest-frequency pass band is allocated to transmission signals (see a solid line 71a in Fig. 9). In addition, a positive voltage is applied to the voltage-control terminals CONT1 and CONT2 to turn on the PIN diodes D10, D11, D13, D14, whereas a negative voltage is applied to the voltage-control terminal CONT3 to turn off the PIN diodes D12 and D15. This permits the band varying capacitors C31, c32, C34, and C35 to be respectively grounded and permits the varying capacitors C33 and C36 to be in an open state, so that the frequency of the pass band of the filter 61 is the second lowest. The second lowest-frequency pass band is also allocated to transmission signals (see a dotted line 71b in Fig. 9).

[0033] Meanwhile, the transmission/reception select switch 14 is set in such a manner that the PIN diodes D4 and D5 are turned on, when a positive voltage is applied to the voltage-control terminals CONT1, CONT2, and CONT3, and when a positive voltage is applied to the voltage-control terminals CONT1 and CONT2, whereas a negative voltage is applied to the voltage-control terminals CONT3. This setting permits the switch 14 to be turned onto the transmission side, and then transmission signals output from the transmission circuit 17 are thereby transmitted to the antenna element 12 via the switch 14 and the frequency variable filter 61.

[0034] In contrast, when the reception circuit 18 shown in Fig. 1 is operated, a negative voltage is applied to the voltage-control terminals CONT1, CONT2, and CONT3 to turn off the PIN diodes D10 to D15. That permits the band varying capacitors C31 to C36 to be in an open state, with the result that the frequency of the pass band of the filter 61 is the highest. The highest-frequency pass band is allocated to reception signals (see a solid line 71d in Fig. 9). In addition, a negative voltage is applied to the voltage-control terminal CONT1 and CONT2 to turn off the PIN diodes D10, D11, D13, and D14, and a positive voltage is applied to the voltage-control terminal CONT3 to turn on the PIN diodes D12 and D15. This permits the band varying capacitors C31, C32, C34, and C35 to be respectively in an open state and permits the band varying capacitors C33 and C36 to be grounded, with the result that the frequency of the pass band of the filter 61 is the second highest. This second-highest pass band is also allocated to reception signals (see a dotted line 71c in Fig.

9).

[0035] Meanwhile, the transmission/reception select switch 14 is set in such a manner that the PIN diodes D4 and D5 are turned off, when a negative voltage is applied to the voltage-control terminals CONT1, CONT2, and CONT3, and also when a negative voltage is applied to the voltage-control terminals CONT1 and CONT2, whereas a positive voltage is applied to the voltage-control terminal CONT3. This permits the switch 14 to be turned onto the reception side, and reception signals input from the antenna element 12 is thereby transmitted to the reception circuit 18 via the frequency variable filter 61 and the switch 14.

[0036] In this way, the filter 61 can have a transmission band and a reception band by allowing the band varying capacitors C31 to C36 to be grounded or to be open by exercising voltage control, and permits the passing frequency to be varied into two phases both within a transmission band and a reception band so as to expand the distance (isolation) between the transmission band and the reception band. Furthermore, in the antenna duplexer of the third embodiment, the frequency variable filter 61 includes a low pass filter comprised of the coupling L16, and capacitors C38 and C39, and a low pass filter comprised of the coupling L17, and capacitors C40 and C41. With this arrangement, unnecessary harmonics such as the second harmonic and the third harmonic of transmission signals generated by the transmission/reception select switch 14 can be efficiently attenuated by the low pass filters. Consequently, conventional problems such as increase in size of a device due to an externally added low pass filter and increase in power consumption can be solved.

[Other Embodiments]

[0037] The antenna duplexer and the communication apparatus in accordance with the present invention are not restricted to those in the above-described embodiments, and various modifications are possible within the range of the scope and spirits of the invention.

[0038] Although the antenna duplexers used in the above embodiments comprise a single dielectric block, this is not the only applicable case. For example, it is possible to use an arrangement in which a dielectric block distributed to each resonator is coupled. Furthermore, the resonator hole may be a hole formed of a step structure having a large-diameter-hole part and a small-diameter-hole part continued thereto, besides a fixed straight-diameter type. The resonator of the frequency variable filter may be, besides a dielectric resonator, a micro-strip line or an LC resonant circuit made by combining an inductor and a capacitor or the like. In addition, in the above embodiment, as shown in Fig. 5, the transmission/reception select switch is formed by combining PIN diodes. However, formation of the switch is not limited to this case, and a publicly-known GaAs switch IC may be used as the switch.

[0039] As described above, according to the present invention, a single frequency variable filter can be used both as a transmission filter and a reception filter so as to achieve reduction in size of the antenna duplexer by disposing a frequency variable filter for switching between a first band and a second band by a voltage-controllable reactor and a transmission/reception select switch connected to an input/output terminal of an end of the frequency variable filter. Moreover, since the frequency variable filter includes a low pass filter, unnecessary harmonics generated by the distortion of transmission signals can be eliminated by the frequency variable filter. As a result, conventional problems such as increase in size of a device due to an externally added low pass filter and increase in power consumption can be solved.

[0040] Furthermore, the first and second bands of the frequency variable filter are respectively divided into a plurality of frequency regions, one of which is selected by exercising voltage control on the reactor. This permits the distance (isolation) between the transmission band and the reception band of the antenna duplexer to be expanded, so that filter characteristics can be even further improved.

Claims

1. A duplexer (15) comprising: a frequency variable filter (13; 13A) switching between a first band and a second band by a voltage-controllable reactor (D1; 51); and a transmission/reception select switch (14) connected to an input/output terminal of an end of the frequency variable filter 13; 13A).

2. The duplexer (15) according to Claim 1, wherein the frequency variable filter includes a low-pass filter (L5, C6, C7).

3. The duplexer (15) according to Claim 1 or Claim 2, wherein the first band and the second band of the frequency variable filter (13) are respectively divided into a plurality of frequency regions, and one of which is selected by exercising voltage-control on the reactor (D1).

4. The duplexer (15) according to Claim 1 to Claim 3, wherein a resonator of the frequency variable filter is a dielectric resonator (24).

5. The duplexer (15) according to Claim 1 to Claim 4, wherein the reactor is a PIN diode (D1).

6. The duplexer (15) according to Claim 1 to Claim 4, wherein the reactor is a field effect transistor (51).

7. The duplexer (15) according to Claim 1 to Claim 6, wherein the transmission/reception select switch is comprised of a PIN diode.

8. The duplexer (15) according to Claim 1 to Claim 6, wherein the transmission/reception select switch is a GaAs switch IC.

9. A communication apparatus (11) comprising the duplexer according to one of Claims 1 to Claim 8.

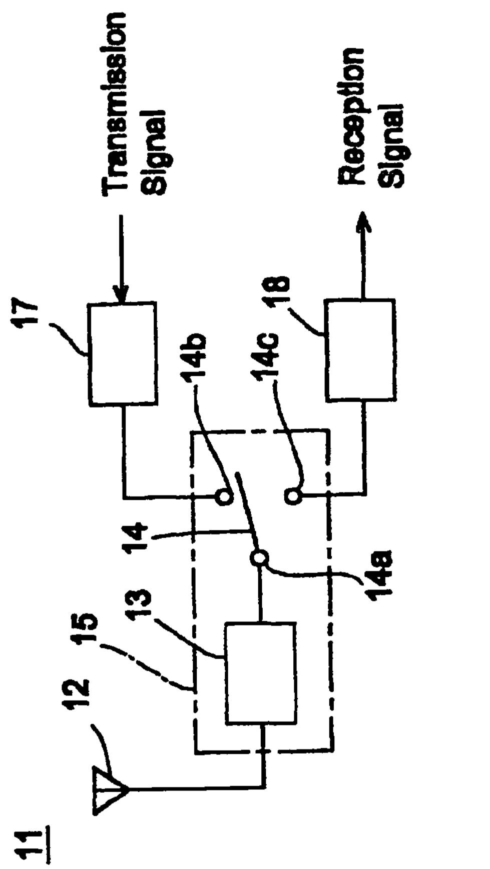

11
12
15
13
14
14a
14b
14c
17
18
Transmission Signal
Reception Signal

Fig. 1

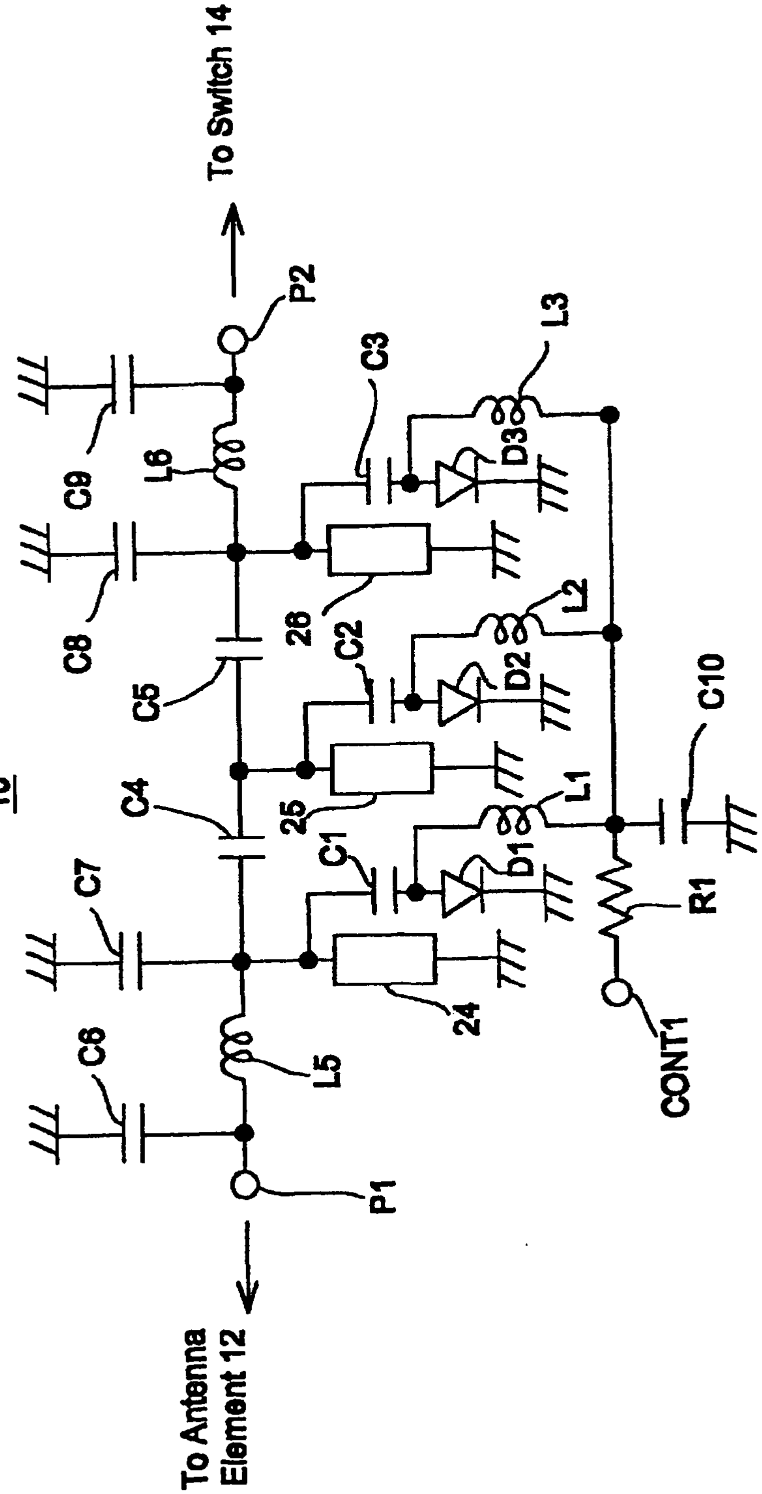
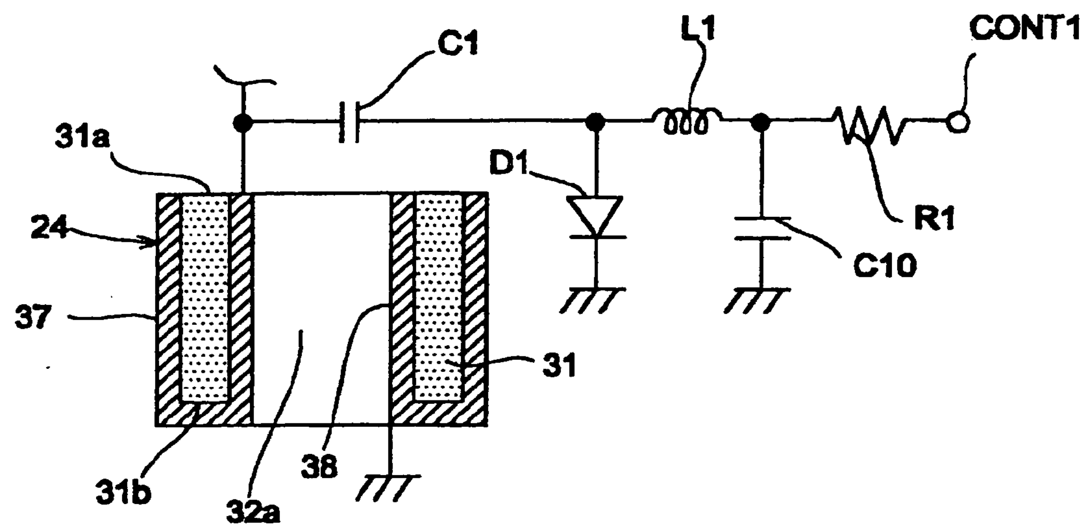

13
To Switch 14
To Antenna
Element 12
P1
P2
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
L1
L2
L3
L5
L6
D1
D2
D3
R1
24
25
26
CONT1

Fig. 2

Fig. 3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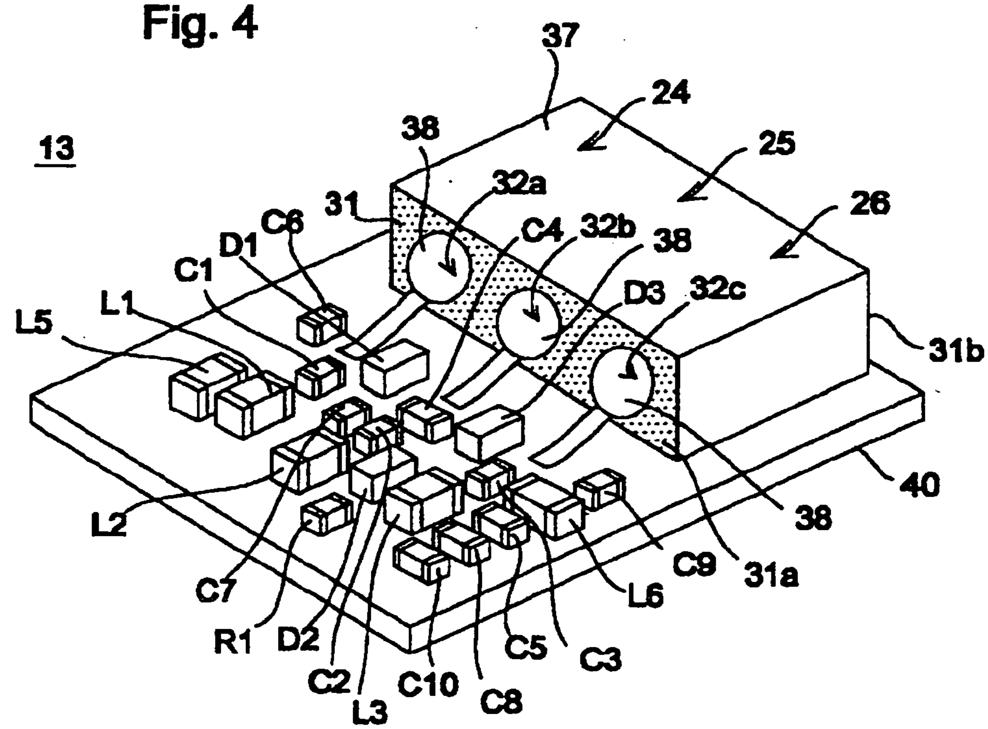
L1
CONT1
31a
D1
24
R1
C10
37
31
38
31b
32a

Fig. 4


37
24
13
38
25
32a
26
31
C6
D1
C4
32b
38
C1
L1
D3
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L5
31b
40
L2
38
C9
31a
L6
C7
R1
D2
C5
C3
C2
C10
C8
L3

Fig. 5

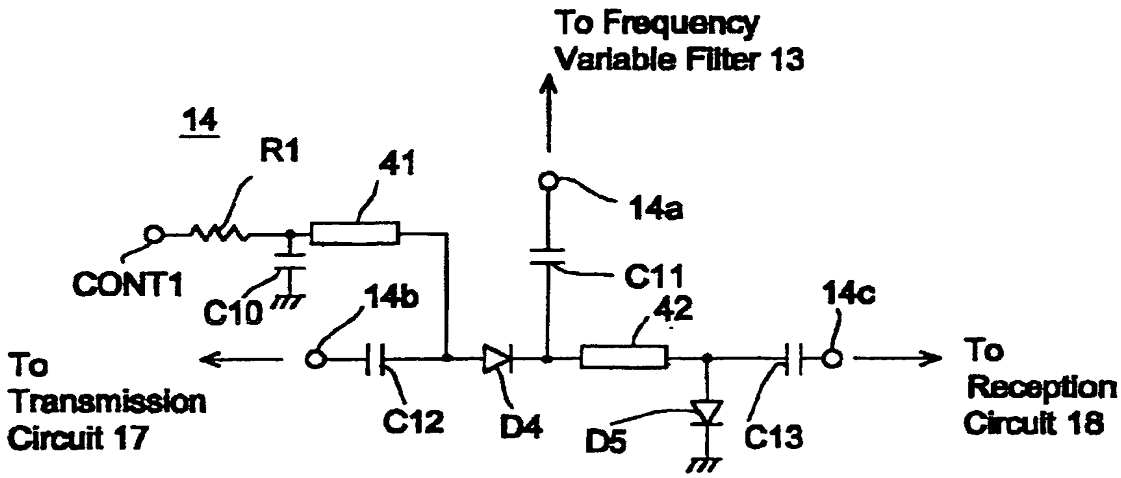
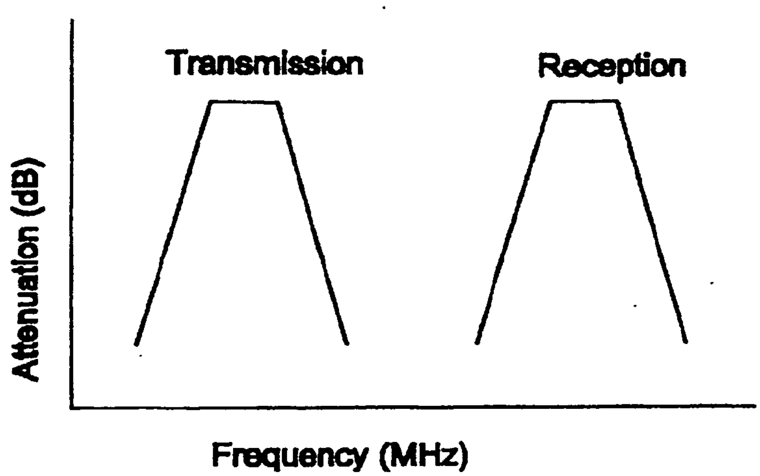
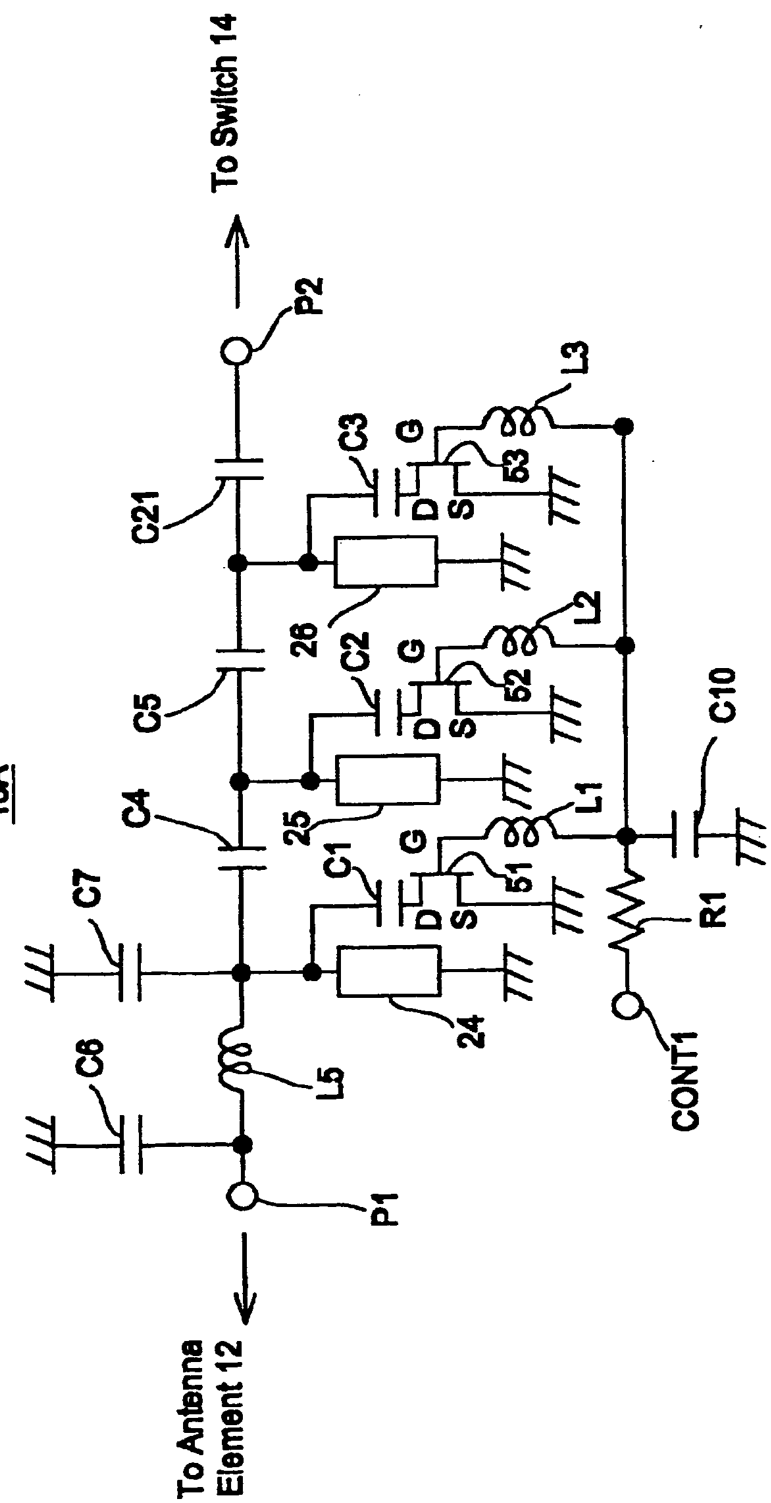

To Frequency
Variable Filter 13
14
R1
41
14a
CONT1
C11
C10
14b
42
14c
To
Transmission
Circuit 17
C12
D4
D5
C13
To
Reception
Circuit 18

Fig. 6


Transmission
Reception
Attenuation (dB)
Frequency (MHz)



13A
To Switch 14
To Antenna Element 12
P1
P2
C6
C7
L5
C4
C5
C21
C1
C2
C3
24
25
26
D
S
G
51
52
53
L1
L2
L3
R1
C10
CONT1

Fig. 7

Fig. 8

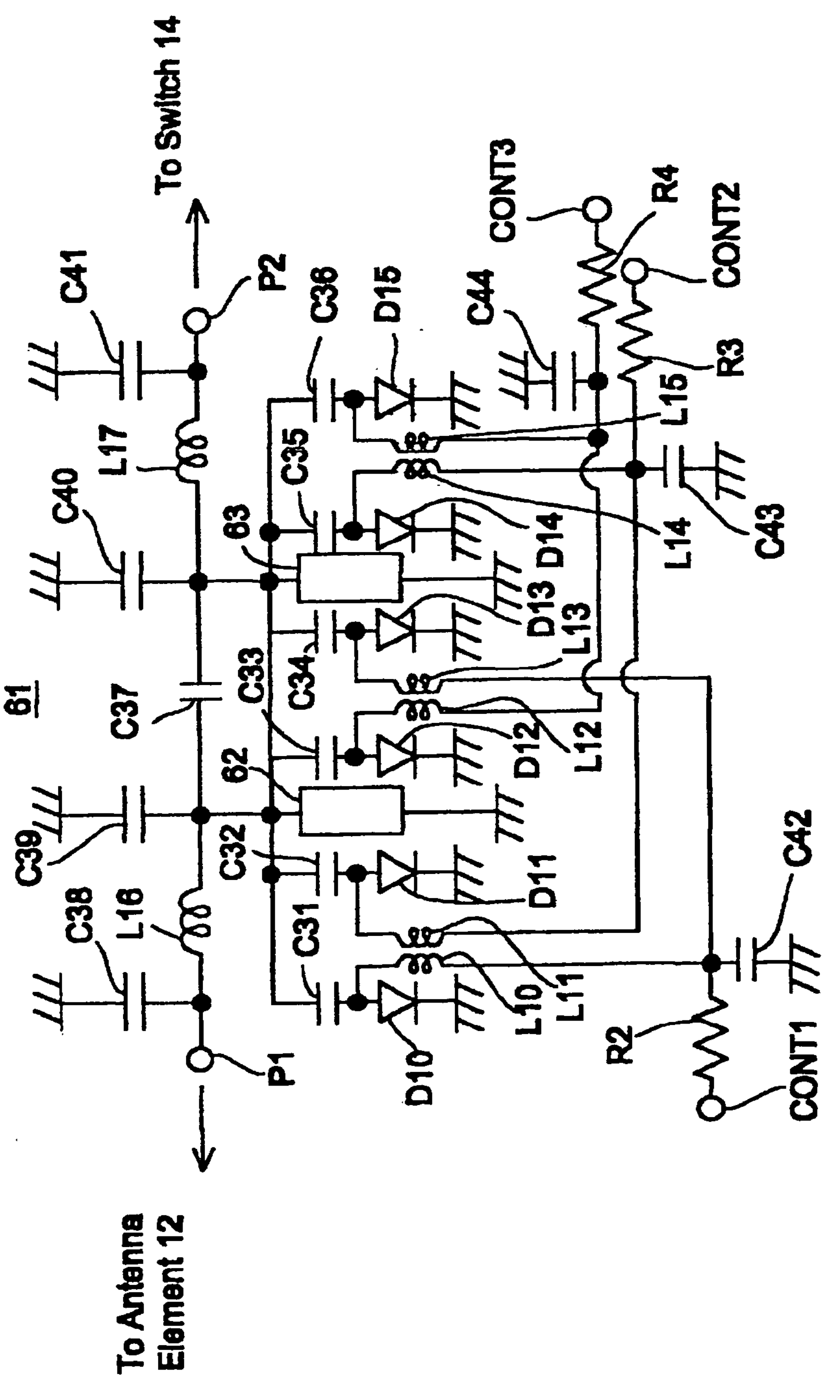

61
To Switch 14
P2
C41
C40
L17
C36
D15
C35
63
D14
L14
C43
C44
L15
R3
R4
CONT3
CONT2
C37
C33
C34
D13
L13
D12
L12
62
C39
C38
L16
C32
D11
C31
L10
L11
D10
P1
C42
R2
CONT1
To Antenna
Element 12

Fig. 9

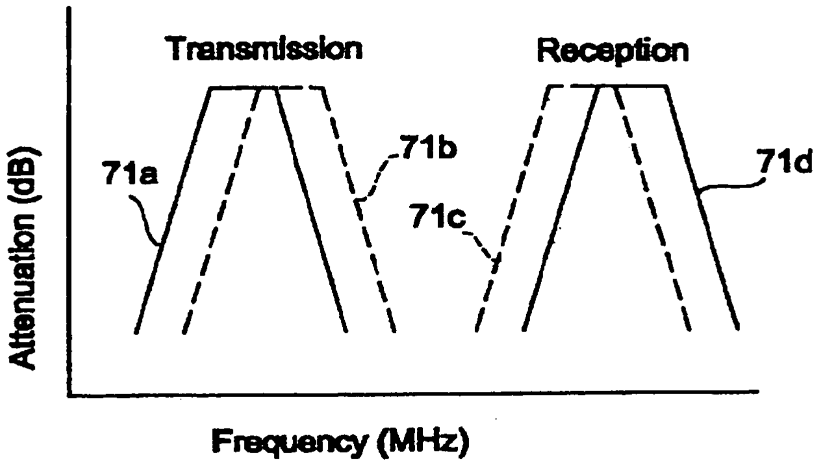
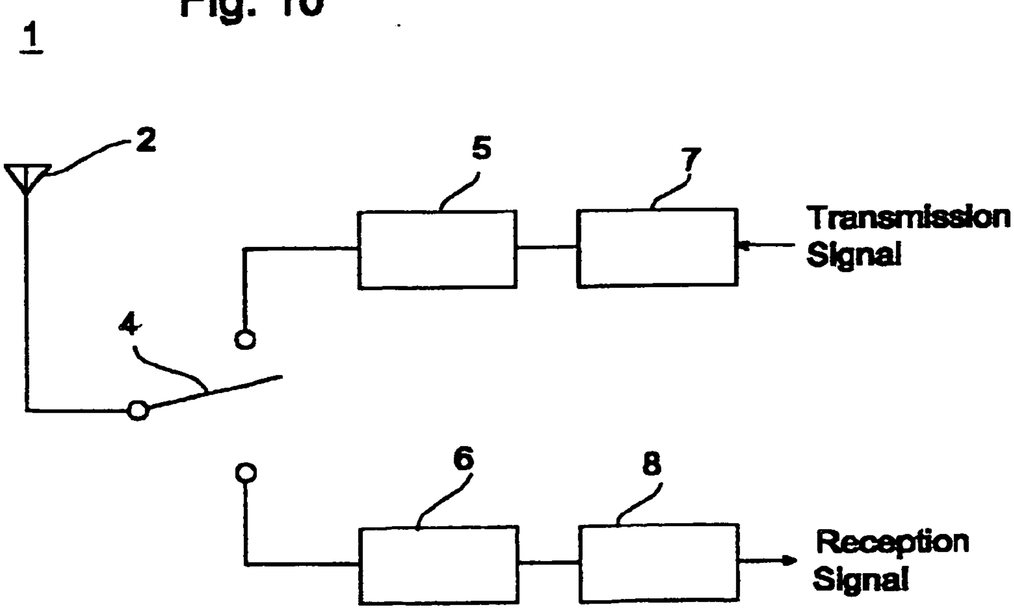

Transmission
Reception
71a
71b
71c
71d
Attenuation (dB)
Frequency (MHz)

Fig. 10


1
2
5
7
Transmission Signal
4
6
8
Reception Signal

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(54) **Duplexer and communication apparatus**

(57) The invention provides a duplexer (15) comprising:

a frequency variable filter (13) switching between a first band and a second band by a voltage-controllable reactor D1; and a transmission/reception select switch (14) connected to an input/output terminal of an end of the frequency variable filter (13).

The above duplexer is small and capable of efficiently eliminating harmonics of transmission signals generated by a transmission/reception select switch.

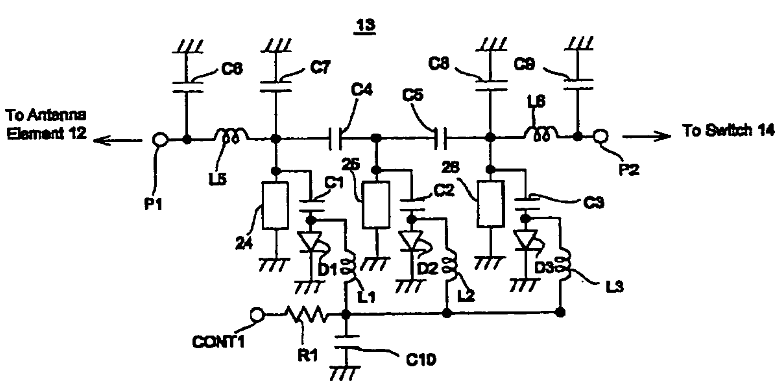

Fig. 2

EP 0 993 063 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 12 0152

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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Place of search	Date of completion of the search	Examiner
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